Fermilab

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CRYOGENIC TESTS AT A1

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Life tests of the Energy Doubler Satellite Refrigeration system components have begun during January of 1980. This report is a short summary of the first 1000 hours of operation. Since one of the purposes of this run was to collect data on the performance of the gas engine, we include summaries of these data. Figures 1 and 2 are a plot of the dry expander adiabatic efficiency* during the run. Table 1 is a summary of gas engine operating data and maintenance. Figure 3 is a bar graph of engine maintenance time and Figure 4 is a bar graph of engine downtime. The gaps in the efficiency data are due to the effect of weekends or short interruptions in the program. The scatter in the data is due to small system oscillations and the difficulty in interpreting vapor pressure thermometers at the ends of their useful ranges. In general, expander efficiency has been quite consistent except for a period between 1/30/80 and 2/1/80 when frozen impurities in the dry engine resulting in excessive blowby caused a reduction in efficiency. This was remedied by simply shutting down and warming the engine slightly.

*Barron, Cryogenic Systems (1966), pg. 166.

The half-cell heat load was measured during this period and was found to be 35 $\pm$ 5W and within the errors is consistent with other measurements. The system was shut down on the evening of March 17 due to the combined effects of a compressor oil pump seal failure, an insulating vacuum leak on the dry engine cryostat, and a leak in the shaft seal on the dry engine. The dry engine continued to maintain its efficiency throughout the last weeks of the run in spite of these accumulating problems. During the course of the run the system warm piping was leak-checked and the wet engine was overhauled in situ without shutting down the refrigerator.

Performance of all systems was found to be adequate, however, it was necessary to run the gas engine at near maximum speed to maintain the desired level of refrigeration. Although the load on the refrigerator was only half of a nominal Doubler cryoloop, since the system was run in the cooldown mode during most of the time full load conditions were adequately simulated.

Table 1

Dry Engine Performance Summary

Week (Sun - Sat)	Approx Avg. Speed (RPM)	Running Time (Hours)	Total Running Time (Hours)	Down-time (Hours)	Maintenance (Man-hours)	Notes on performance	Approx. Average Efficiency
Jan 6-12	220	98	98	10	25	Piston shaft bal seal replaced by chevron. Pump cavition problems in hydraulics.	58%
Jan 13-19	180	167	265	1	3	Reset emergency brake trip speed. Larger orifice installed in hydraulic valve.	55%
Jan 20-26	180	167 1/2	432 1/2	1/2	2	Changed emergency brake plate for higher speed trip.	61%
Jan 27 - Feb 2	300	143 1/2	576	1/2	1	After refrig shutdown engine up with apparent contamination of seal or valve.	30%
Feb 3-9	500	143	719	1	6	Threads on exhaust relief cracked, leaking, frosted. Replaced. Frost around shaft seal.	65%
Feb 10-16	500	168	887	0	4	Periodically warmed and tightened shaft seal to try to eliminate frost.	65%
Feb 17-23	500	10	897	8	10	Fitting on exhaust relief cracked, Replaced. Insulating vacuum bad.	65%
Totals		897		21	51		

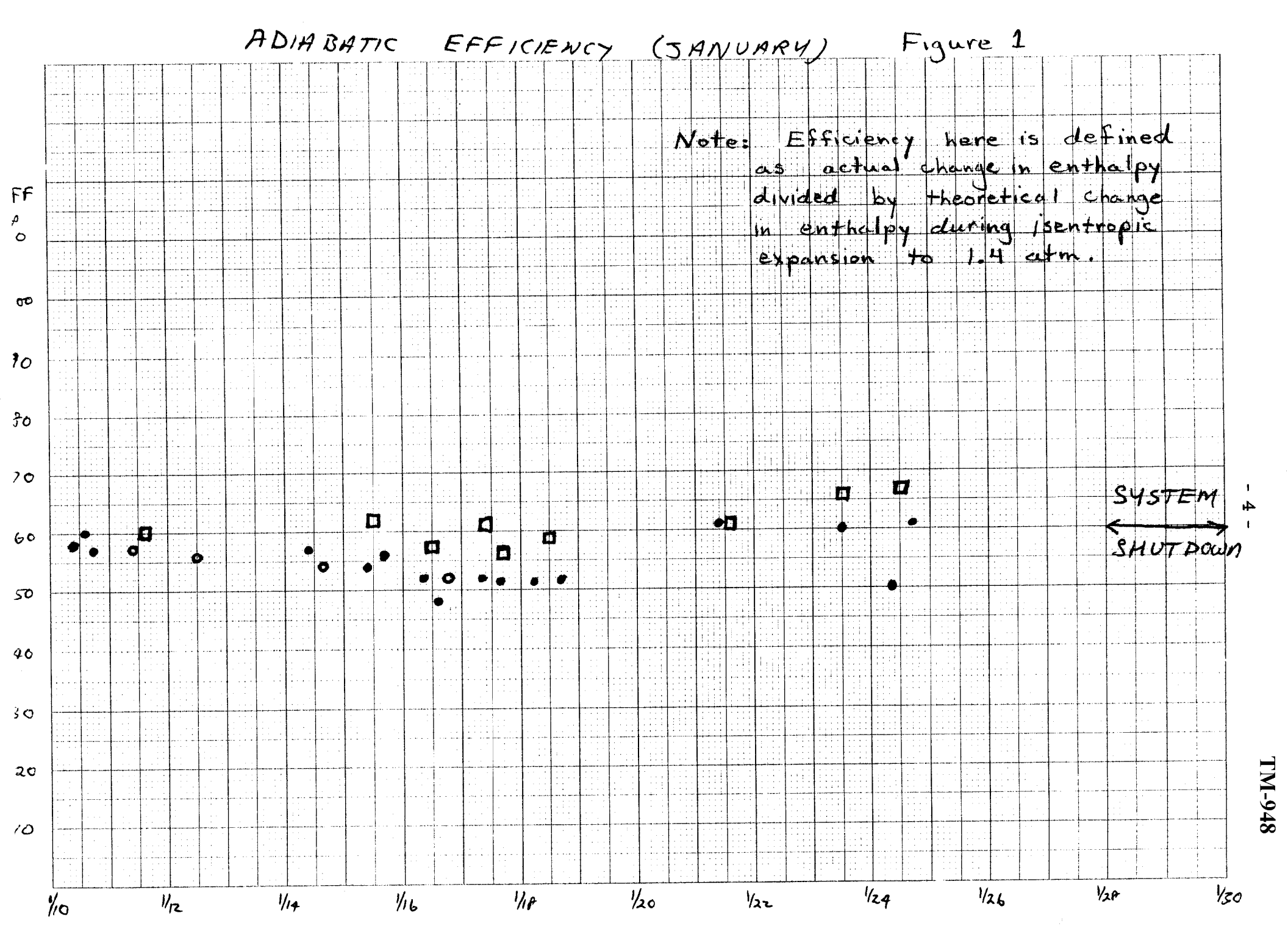
ADIABATIC EFFICIENCY (JANUARY)
Figure 1
Note: Efficiency here is defined as actual change in enthalpy divided by theoretical change in enthalpy during isentropic expansion to 1.4 atm.
FF
ρ
0
80
70
60
50
40
30
20
10
1/10
1/12
1/14
1/16
1/18
1/20
1/22
1/24
1/26
1/28
1/30
SYSTEM
SHUTDOWN

Figure 2

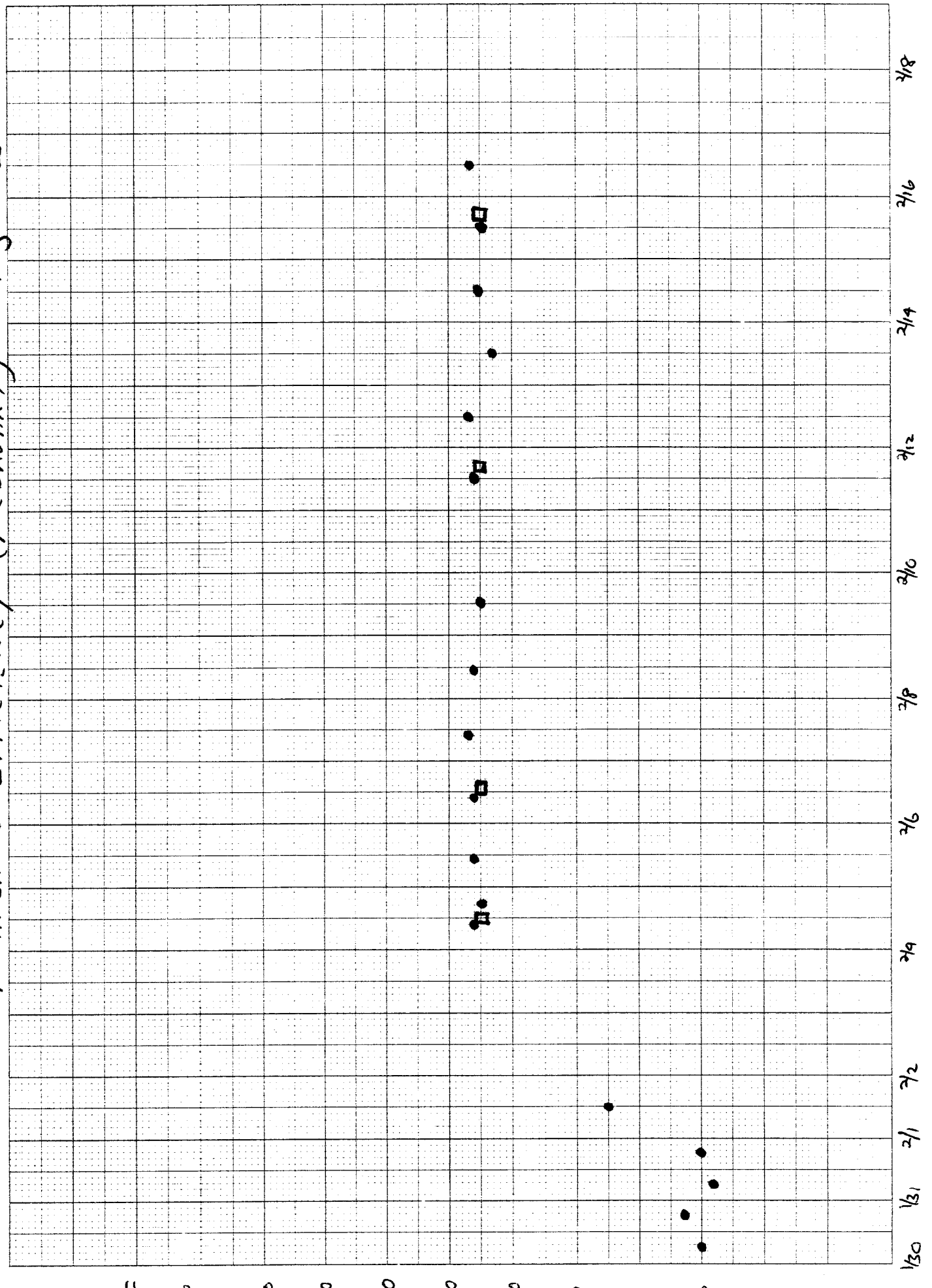
ADIABATIC EFFICIENCY (FEBRUARY)
EFF %
100
90
80
70
60
50
40
30
20
10
1/30
1/31
2/1
2/2
2/4
2/6
2/8
2/10
2/12
2/14
2/16
2/18

Figure 3
A1 Dry Engine
Weekly Maintenance Time
Jan 6 - Feb 23, 1980

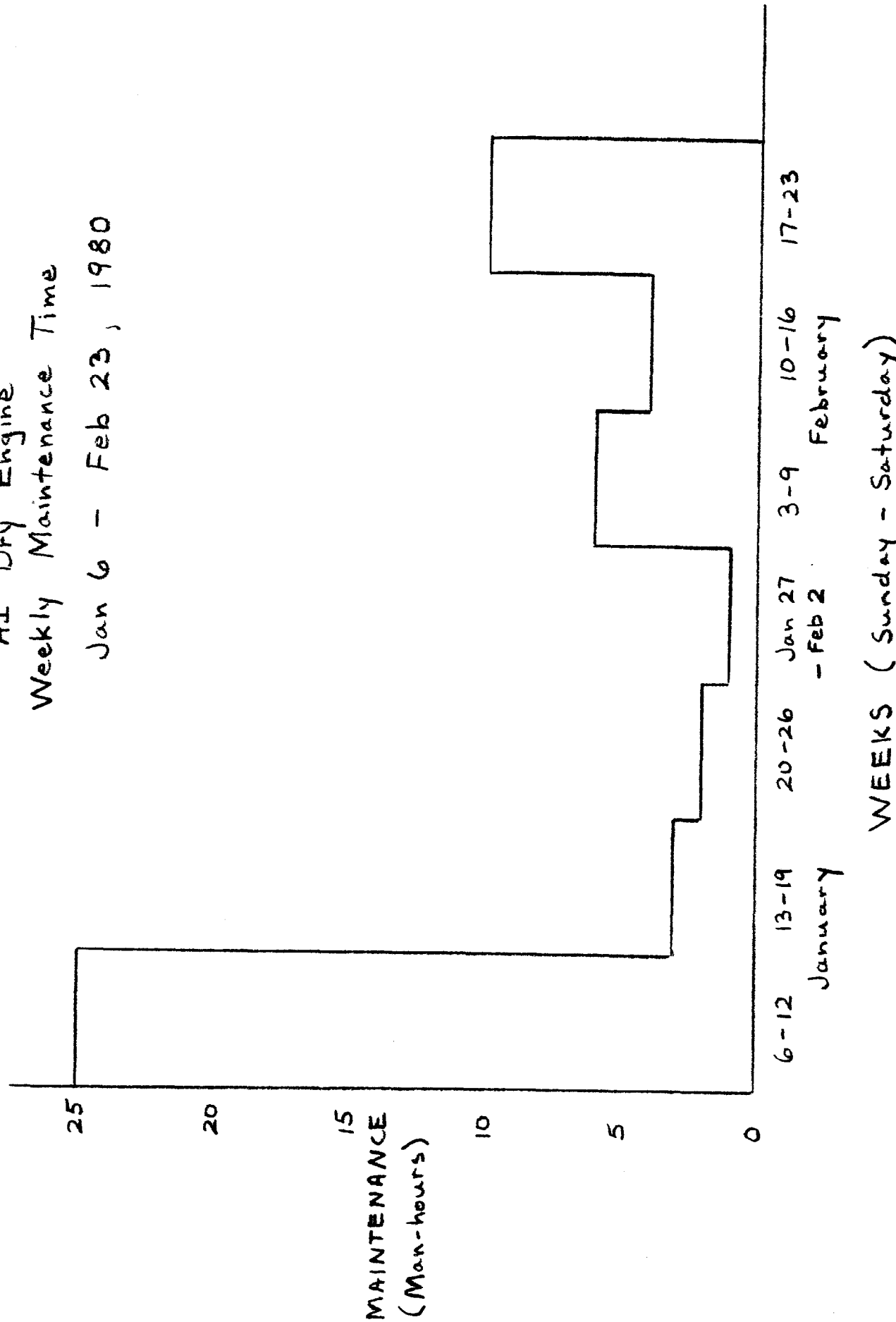

Figure 4
A1 Dry Engine
Weekly Downtime
Jan 6 - Feb 23, 1980